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System design for integrated water modelling

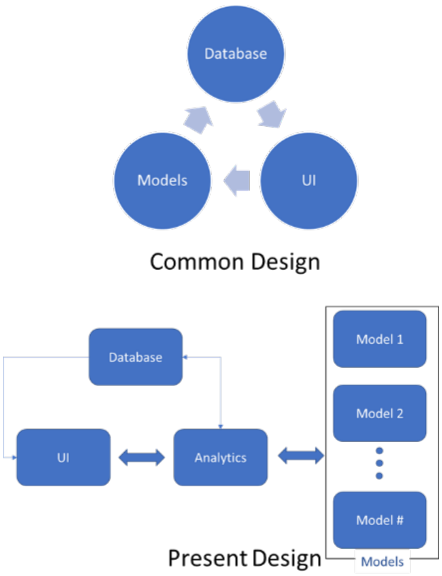
C. Chen [a], M. van der Sterren [a] and J. Martin [b]

[a] *Strategy and Performance, WaterNSW*
[b] *Operations, WaterNSW*
Email: chris.chen@waternsw.com.au

Abstract: WaterNSW is responsible for the management and operation of Greater Sydney Dams that supplies water to more than 5 million people in Sydney and the Illawarra, Blue Mountains, Shoalhaven, Goulburn, and Southern Highlands regions. WaterNSW is developing an integrated water quantity and quality model from the catchment to the supply system for Greater Sydney. The decision support system (DSS) housing these models (CARM) aims to help decision makers to better understand the water quantity and quality conditions in the catchments and waterbodies managed by WaterNSW.

The DSS has become increasingly popular for tackling complex problems in integrated water resources management. The aim of such systems is to provide decision-makers with insights based on real-time data, allowing for timely and informed decisions. To achieve this, the DSS automates the analytical process to generate the required data. Typically, a DSS is composed of three major components: a database component, a model component, and a user interface (UI) component.

However, the common system design can encounter challenges in providing a transparent workflow to end-users. Water models for different purposes must be able to communicate with each other to produce meaningful results. For example, lake models need to adopt the results from rainfall-runoff models to provide the more accurate estimates for water quality variation over time. This has led to the development of systems that include additional components beyond the traditional three-component design to handle the data processing requirements among models. One common issue with the traditional design is that they may not allow for the modification of state variables among models within a workflow, which can limit the ability to perform scenario modelling analysis. Therefore, the deeply embedded data analytical processes in the common system design not only make development inefficient when there is a requirement to reuse the analytical components in a new modelling workflow, but also prevent the flexibility in scenario modelling analysis for decision makers.



To address these challenges, we present the design of CARM, a DSS for multiple water management applications, including water planning and operations. An additional analytics component is included in the design. The components within CARM are loosely coupled under an asynchronous framework, which allows for efficient data analysis and processing. The analytics component is a scalable computational module using the Flask library, which is independent of the UI and model components. Since the model data preparation and processing are dispatched to the analytics module, there is an independent model simulation lifecycle for each model, consisting of the catchment runoff model, hydrodynamic lake model, and water supply system model. This system design in CARM enables re-analysis to be carried out at any part of the modelling workflow in parallel.

In summary, the design of CARM addresses the challenges commonly encountered by DSS in water management by providing a transparent workflow for end-users and a unified system for multiple purposes. The loose coupling of components under an asynchronous framework enables efficient data analysis and processing, while the distribution of analytics into a scalable computational module enhances the system's scalability, reusability and flexibility. The system design of CARM offers a promising approach to integrating water quantity and quality models into a DSS for water management.

Keywords: *Decision support system, integrated water modelling, integrated water resources management, water quality, modelling system design*